HWCI 3.4.1
Data Acquisition & Command

ULDB
PDR

3.4.1
Data
Acquisition &
Command

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Code 584W
November 4-5,1998

1553 Bus Wiring

Data Bus Wiring

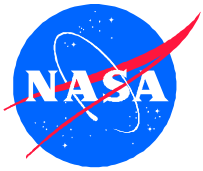Data Through Balloon

Acquisition & Command Stacks

- PDU Stacks

- System Stacks

- Backup Command Decoder

PCM Encoder Stack

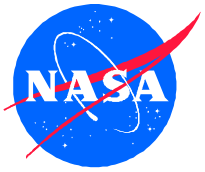Data Switching Unit

Data Distribution Unit

RF Cables

HWCI 3.4.1
Data Acquisition & Command

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**3.4.1
Data
Acquisition &
Command**

Linda Thompson
Code 584W
November 4-5,1998

- Requirements Traceability
  - Data Acquisition & Command
    - **DTRD section 3.4.1.1**
    1. Science Instrument and Housekeeping data shall be acquired by the flight computer for processing, archiving, and transmission.
    2. The interface for the transfer of data shall be MIL-STD-1553B
    3. The bit rate of the data shall be a minimum of 9 kbs.
    - **DTRD section 3.4.1.2**
    1. Support Subsystem Housekeeping data, Engineering data and Mission Operations data shall be acquired by the flight computer for processing, archiving, and transmission. This shall include data from the gondola, from the terminate system, and from the CAP.
    2. Analog data acquisition, discrete digital data acquisition, and data acquired from subsystems in subsystem-specific interfaces shall be supported
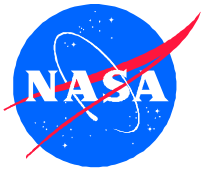   3. The overall mission users' effective bit rate shall be 100 bps or less.

**3.4.1
Data
Acquisition &
Command**

HWCI 3.4.1.1
1553 Bus Wiring
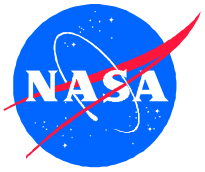
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3.4.1
Data
Acquisition &
Command

HWCI 3.4.1.1
1553 Bus Wiring

- Functional and Performance Requirements

  3.4.1.1.a - Provide MIL-STD 1553B wiring for science computer data and commands

  3.4.1.1.b - Support science data bit rates up to 9 kbps

  3.4.1.1.c - Provide MIL-STD 1553B wiring for TDRSS transponder data and commands

  3.4.1.1.d - Provide conformance to MIL-STD 1553B

  3.4.1.1.e - Provide redundant bus architecture

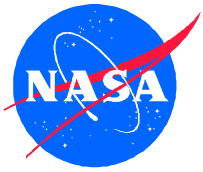 3.4.1.1.f - Maintain functionality in exposed ULDB flight environment for mission duration

HWCI 3.4.1.1
1553 Bus Wiring

ULDB
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3.4.1
Data
Acquisition &
Command

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- Trade Studies
  - Known compatibility with selected MIL-STD 1553B hardware.
  - Exceeded environmental requirements

- Description
  - Mechanical
    - Dimensions
      - Bus Coupler w/ Transformer:
        1.17" H x 2.26" W x 5.25" L
      - Terminator:
        1.68" L
    - Weight: .6690 lb.
    - Connectors: TRB 3
  - Environmental
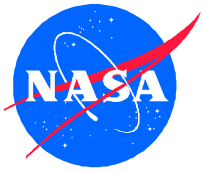   - Operating temperature: -55° C to +130° C

ULDB
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3.4.1
Data
Acquisition &
Command

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HWCI 3.4.1.1
1553 Bus Wiring

- Description
  - Electrical
    - Data:
      - Serial local area network w/ redundant buses.
      - The data is sequentially transmitted and received in a multiplexing scheme over two copper wires from computer to computer.
      - Bit rate: 1 Mbps.
    - Cables:
      - Two-conductor shielded twisted pair
      - Four twist per foot, min.
      - 78 ohm nominal impedance
      - Teflon jacket and insulation material
    - Bus Couplers
      - Reduce reflections, protect the bus, and maintain impedance of the bus
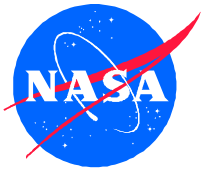   - 1.41:1 Transformer turns ratio

HWCI 3.4.1.1
1553 Bus Wiring

ULDB
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3.4.1
Data
Acquisition &
Command

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- Risk Assessment & Mitigation/Reliability
  - Previous Flight History
    - F16 - Bosnia
    - Future flights on Space Shuttle
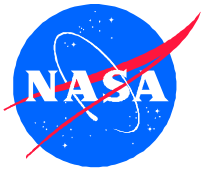   - Plans to be used on the Space Station
  - COTS

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**3.4.1
Data
Acquisition &
Command**

HWCI 3.4.1.2
Data Bus Wiring

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November 4-5,1998

HWCI 3.4.1.2
Data Bus Wiring

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3.4.1
Data
Acquisition &
Command

- Functional and Performance Requirements

  3.4.1.2.a - Provide analog data wiring from Ballooncraft sensors to acquisition electronics

  3.4.1.2.b - Provide digital data wiring from Ballooncraft sensors to acquisition electronics

  3.4.1.2.c - Provide digital data wiring from UTP to Ballooncraft

  3.4.1.2.d - Provide AART digital data wiring from Ballooncraft subsystems to flight processors

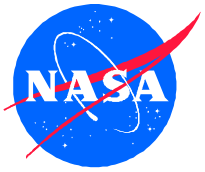 3.4.1.2.e - Maintain functionality in exposed ULDB flight environment for mission duration

HWCI 3.4.1.2
Data Bus Wiring

- Description
  - Mechanical
    - Dimensions (nominal diameter inches, mm)
      - Single Twisted Pair, 22 AWG: 0.18, 4.6
  - Environmental
    - Temperature: -80° C to +200° C
    - Humidity: 100% Impervious
  - Electrical
    - Operating Voltages: To 300 Volts
    - Conductor: Stranded Tinned Copper
    - Insulation: Color-Coded FEP Teflon
    - Shield: Aluminum/Polyester/Aluminum Foil with Stranded Tinned Copper Drain Wire
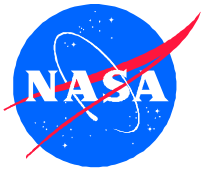   - Jacket: FEP Teflon

HWCI 3.4.1.2
Data Bus Wiring

ULDB
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3.4.1
Data
Acquisition &
Command

- Risk Assessment & Mitigation/Reliability
  - No known risk
  - High reliability
  - Design to meet "Design & Manufacturing Standard for Electrical Harnesses" ISO 565-PG-8700-2.1
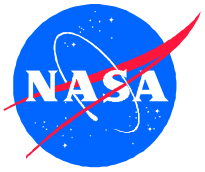 - COTS

**ULDB
PDR**

**3.4.1
Data
Acquisition &
Command**

HWCI 3.4.1.3
Data Through Balloon

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Code 584W
November 4-5,1998**

HWCI 3.4.1.3
Data Through Balloon

**ULDB
PDR**

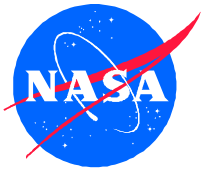**3.4.1
Data
Acquisition &
Command**

**Linda Thompson
Code 584W
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- Functional and Performance Requirements

  3.4.1.3.a - Provide digital data wiring from CAP to UTP

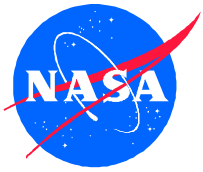 3.4.1.3.b - Maintain functionality in exposed ULDB flight environment for mission duration

HWCI 3.4.1.3
Data Through Balloon

- Trade Studies
  - Bus Wiring
    - Current selection
  - Wireless Transceivers
    - Under evaluation
  - Fiber Optics

- Description
  - Mechanical
    - Dimensions (nominal diameter inches, mm)
      - Single Twisted Pair, 22 AWG: 0.18, 4.6
  - Environmental
    - Temperature: -80° C to +200° C
    - Humidity: 100% Impervious

HWCI 3.4.1.3
Data Through Balloon

ULDB
PDR

3.4.1
Data
Acquisition &
Command

- Description
  - Electrical
    - Operating Voltages: To 300 Volts
    - Conductor: Stranded Tinned Copper
    - Insulation: Color-Coded FEP Teflon
    - Shield: Aluminum/Polyester/Aluminum Foil with Stranded Tinned Copper Drain Wire
   - Jacket: FEP Teflon

HWCI 3.4.1.3
Data Through Balloon

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**3.4.1
Data
Acquisition &
Command**

- Risk Assessment & Mitigation/Reliability
  - Flown on LDB Flights, shown reliable
  - Design to meet "Design & Manufacturing Standard for Electrical Harnesses" ISO 565-PG-8700-2.1
  - COTS

  - Trade studies are continuing on Wireless Transceivers. A final selection between bus wiring and wireless transceivers will be based upon the outcome of testing on balloon material for static charge buildup.
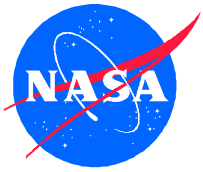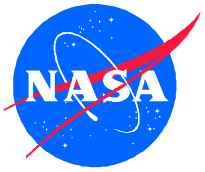
HWCI 3.4.1.4.
Data Acquisition & Command Stacks

**Linda Thompson
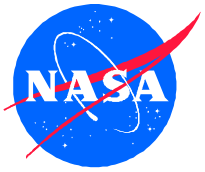Code 584W
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3.4.1
Data
Acquisition &
Command

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HWCI 3.4.1.4.1
Power Distribution Unit Stack

- Functional and Performance Requirements

  3.4.1.4.1.a - Provide multiple channels of analog data
  acquisition (A/D conversion)

  3.4.1.4.1.b - Provide multiple channels of discrete digital
  data acquisition

  3.4.1.4.1.c - Provide interface to flight processors to
  transfer acquired data

  3.4.1.4.1.e - Maintain functionality in exposed ULDB
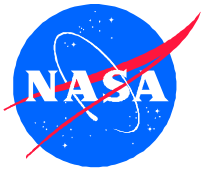 flight environment for mission duration

HWCI 3.4.1.4.2
System Stacks

- Functional and Performance Requirements

    3.4.1.4.2.a - Provide multiple channels of analog data acquisition (A/D conversion)

    3.4.1.4.2.b - Provide multiple channels of discrete digital data acquisition

    3.4.1.4.2.c - Provide interface to flight processors to transfer acquired data

    3.4.1.4.2.d - Provide discrete outputs for execution of commands

    3.4.1.4.2.e - Provide timed command output

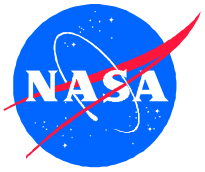   3.4.1.4.2.f - Maintain functionality in exposed ULDB flight environment for mission duration

ULDB
PDR

3.4.1
Data
Acquisition &
Command

HWCI 3.4.1.4.3
Backup Command Decoder Stack

- Functional and Performance Requirements

    3.4.1.4.3.a - Receive commands from ulink command
                   receiver

    3.4.1.4.3.b - Decode and error check received commands

    3.4.1.4.3.c - Execute commands via discrete outputs

    3.4.1.4.3.d - Maintain functionality in exposed ULDB
                   flight environment for mission duration
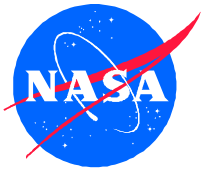
HWCI 3.4.1.4
Data Acquisition & Command Stacks

- Overview
  - Designed to provide analog and digital data acquisition, digital command outputs (open collector), and timed command outputs.
  - Designed as an expandable "stack" up system with a vertical bus structure distributing communications, regulated power, address, clocks, and other functions to each deck
  - Communication protocol is RS232 compatible and the format is that of an Addressable Asynchronous Receiver transmitter (AART)
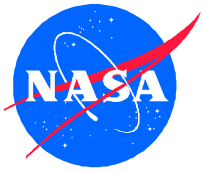 - Message to and from the stack consists of a two byte transmission

HWCI 3.4.1.4
Data Acquisition & Command Stacks

- Trade Studies
  - Essential Service Nodes (ESN's)
    - Costly
    - Unknown engineering and development time
  - Data Acquistion & Command Stacks
    - Known performance
  - On-board Computer Cards
    - Under consideration, determination will be based on outcome of further Trade Studies on software development and hardware risk
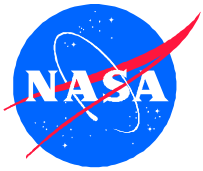
ULDB
PDR

3.4.1
Data
Acquisition &
Command

HWCI 3.4.1.4
Data Acquisition & Command Stacks

- Description
  - Mechanical
    - Dimensions (per deck): 5" H x 7" W x .562" D
    - Mass – Weight (lbs.): <2lbs.
    - Vertical stack machined from aluminum plate stock. Four #8x32 screws from the top through keenserts in the base hold the stack decks in compression
  - Environmental
    - Temperature: -40°C to +60°C
    - Shock: 50 Grms for 11 ms
  - Electrical
    - Power Consumption
      - Power Supply / serial I/O deck: 1 Watt
      - All other decks: < 1 Watt
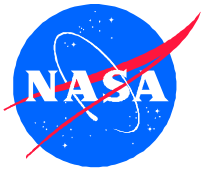
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3.4.1
Data
Acquisition &
Command

HWCI 3.4.1.4
Data Acquisition & Command Stacks

– Electrical

- Deck Description.
    – Power supply/serial I/O deck:
        - Provides mounting for a stack of user specified modules, regulated isolated +/- 12 volts and +5 volt power to stack, power on reset to the stack, and serial I/O driver/receivers for communicating with the stack.
        - Supports baud rates from 300 to 4800 baud.
    – .Housekeeping deck
        - Contains a AART for serial I/O, a low power 12 bit analog to digital converter, a 16 bit digital latch defaulted to transparent, and a 32 channel analog multiplexer.
    – .Event Counter deck
        - Is a digital data acquisition deck designed to monitor events or time. The deck has one 16 bit counter and four eight bit counters, each of which must be accessed as part of a housekeeping deck via an address.
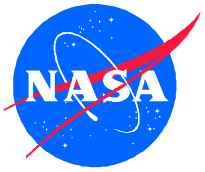
ULDB
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3.4.1
Data
Acquisition &
Command

HWCI 3.4.1.4
Data Acquisition & Command Stacks

– Electrical

  – .Discrete Command deck

    • Contains 28 active low (open collectors) outputs for executing command functions.

  – .Timed Command deck

    • Provides a means to remotely execute a time critical command from a system that is not real-time oriented.

  – .Backup Command Power Supply deck

    • Similar to the normal base unit with the exclusion of the serial I/O RS232 transmitter/receiver plus the dual supplies are replaced with a 5 volt only power supply.

  – .Low Power Base with Opto-isolation deck

    • Designed for above-the-rotator applications such as terminate stack, parachute cutaway stack and top stack. It has a very low quiescent power non-isolating switching regulator to power the required decks, such as, backup command deck, discrete command deck, housekeeping deck and timed command deck.
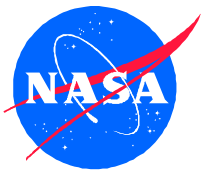
HWCI 3.4.1.4
Data Acquisition & Command Stacks

ULDB
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3.4.1
Data
Acquisition &
Command

- System Stack
  - Designed to primarily handle the control of housekeeping data

- Power Distribution Unit Stack
  - Designed to control and monitor the power switching of all units on the balloon

- Backup Command Decode Stack
  - Designed to serve as a backup computer in case of failure of the flight computers
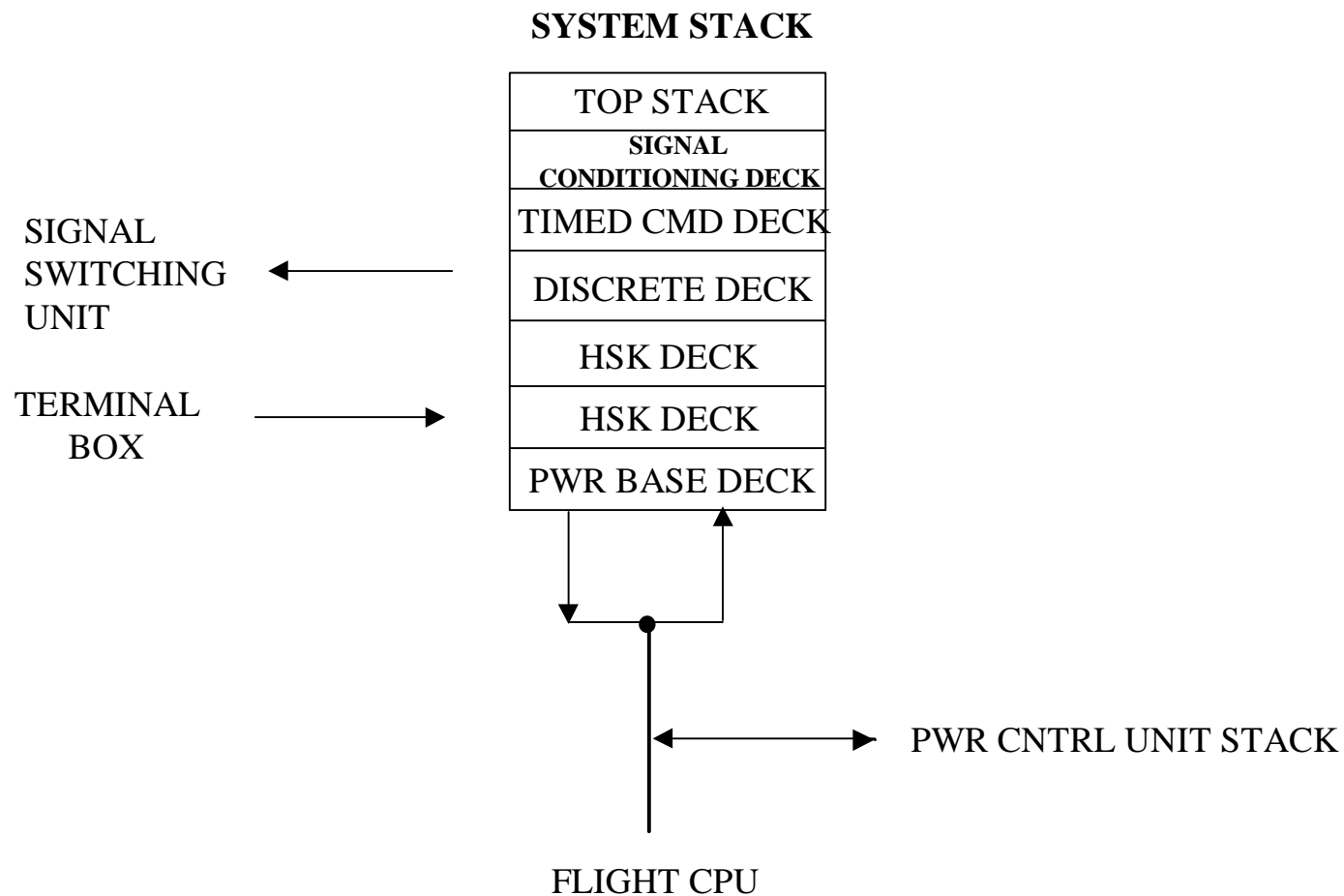 - Provides limited command capability

**ULDB
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**3.4.1
Data
Acquisition &
Command**

SYSTEM STACK

TOP STACK
SIGNAL CONDITIONING DECK
TIMED CMD DECK
DISCRETE DECK
HSK DECK
HSK DECK
PWR BASE DECK

SIGNAL
SWITCHING
UNIT

TERMINAL
BOX

PWR CNTRL UNIT STACK

FLIGHT CPU

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HWCI 3.4.1.4
Data Acquisition & Command Stacks

3.4.1
Data
Acquisition &
Command

POWER CONROL UNIT STACK

| TOP PLATE |
| DISCRETE DECK |
| DISCRETE DECK |
| HSK DECK |
| HSK DECK |
| PWR BASE DECK |

TERMINAL BOX
(HSK)

CHARGE
CONTROLLER
AND BATTERIES

SYSTEM STACK

FLIGHT CPU

**ULDB
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**3.4.1
Data
Acquisition &
Command**

**Linda Thompson
Code 584W
November 4-5,1998**

BACKUP COMMAND DECODE STACK

SIGNAL SWITCHING
UNIT

LOS CMD

DATA / CMDS

| TOP PLATE |
| **BACKUP CMD DECODE DECK** |
| TIMED DECK |
| DISCRETE DECK |
| DISCRETE DECK |
| DISCRETE DECK |
| PWR BASE DECK |

POWER
CONTROL
UNIT

ULDB
PDR

3.4.1
Data
Acquisition &
Command

HWCI 3.4.1.4
Data Acquisition & Command Stacks

- Risk Assessment & Mitigation/Reliability
  - Flown on LDB Flights, shown reliable
  - Technology is 10 years old and some components are becoming obsolete

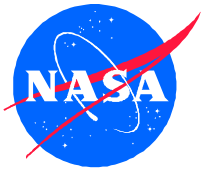 - On-board Computer Cards are still under consideration

ULDB PDR

**3.4.1
Data
Acquisition &
Command**

**Linda Thompson
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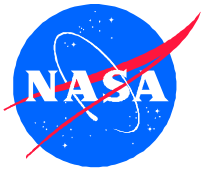November 4-5,1998**

HWCI 3.4.1.5
PCM Encoder Stack

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HWCI 3.4.1.5
PCM Encoder Stack

**ULDB
PDR**

**3.4.1
Data
Acquisition &
Command**

- Functional and Performance Requirements

    3.4.1.5.a - Provide multiple channels of analog data acqisition (A/D conversion)

    3.4.1.5.b - Provide multiple channels of discrete digital data acquisition

    3.4.1.5.c - Provide multiple channels of RS-232 data acquisition

    3.4.1.5.d - Provide encoded data to FM transmitter to transfer acquired data

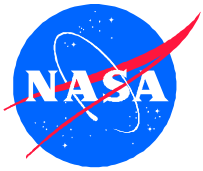   3.4.1.5.e - Maintain functionality in exposed ULDB flight environment for mission duration

HWCI 3.4.1.5
PCM Encoder Stack

ULDB
PDR

3.4.1
Data
Acquisition &
Command

- Overview
  - WFF93
    - In-house PSL design developed originally for sounding rockets
    - Modular design system
    - Incorporates multiple serial input links in addition to both analog and digital input signals
    - Supports one of eight binary related bit rates from 10 Mbps to 78Kbps
    - Format structure is configured by a software program into a non-volaltile EEPROM
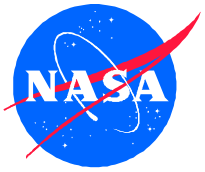
ULDB
PDR

3.4.1
Data
Acquisition &
Command

HWCI 3.4.1.5
PCM Encoder Stack

- Trade Studies
  - Considered other COTS PCM Encoders

- Description
  - Mechanical
    - Depth (inches): 4.00
    - Height (inches): Power supply deck / base: .375
      - Lid: .550
      - Data and Control decks (each): .375
    - Mass: Weight (lbs / g): <.3 / 150 per deck
    - Mounting: Vertical plane using compression screws, horizontal plane with connectors facing up or using right angle brackets
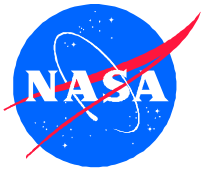
HWCI 3.4.1.5
PCM Encoder Stack

**ULDB
PDR**

**3.4.1
Data
Acquisition &
Command**

- Description
  - Environmental
    - Operating Temperatures
      - Power Supply Deck: -55°C to +85°C
      - All other Decks: -20°C to +60°C
    - Shock: 50 Grms for 11 ms
  - Electrical
    - Power consumption:
      - Power Supply Deck: 1.68 to 4.2 Watts
      - All other decks: ≤ .685 Watts
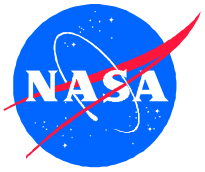
**Linda Thompson
Code 584W
November 4-5,1998**

HWCI 3.4.1.5
PCM Encoder Stack

- Risk Assessment & Mitigation/Reliability

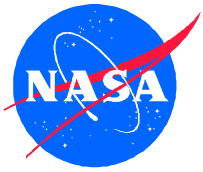 – High reliability, used in the Sounding Rocket Program
  – COTS

**ULDB
PDR**

**3.4.1
Data
Acquisition &
Command**

**Linda Thompson
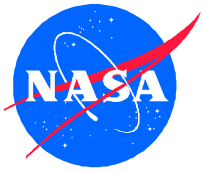Code 584W
November 4-5,1998**

HWCI 3.4.1.6
Data Switching Unit

HWCI 3.4.1.6
Data Switching Unit

- Functional and Performance Requirements

  3.4.1.6.a - Route command data from uplink command receivers to required destinations

  3.4.1.6.b - Route Ballooncraft data to required destinations

  3.4.1.6.c - Buffer data to multiple simultaneous destinations

  3.4.1.6.d - Buffer command data to multiple simultaneous destinations

  3.4.1.6.e - All route switching to be controllable via flight computers' discrete command outputs

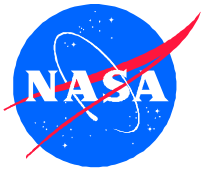 3.4.1.6.f - Maintain functionality in ULDB environment for mission duration

HWCI 3.4.1.6
Data Switching Unit

ULDB
PDR

3.4.1
Data
Acquisition &
Command

Linda Thompson
Code 584W
November 4-5,1998

- Overview
  - Receives commands from the ground and routes to appropriate devices such as CPU1, CPU2, and Backup Command Decode Stack
 - In-house fabricated boards

HWCI 3.4.1.6
Data Switching Unit

**3.4.1
Data
Acquisition &
Command**

MKS SENSORS

TDRSS I DATA XCVR — TDRSS I DATA CPU1 / TDRSS I DATA CPU2

TDRSS Q DATA XCVR — TDRSS Q DATA CPU1 / TDRSS Q DATA CPU2

ROTATOR PROCESSOR — ROTATOR PORT CPU 1 / ROTATOR PORT CPU 2

TERMINATE + CAP — BALLOON CONTROL PORT CPU 1 / BALLOON CONTROL PORT CPU 2

HI 1 / HI 2 — S/S 1 / S/S 2

MID 1 / MID 2 — S/S 1 / S/S 2

LO 1 — S/S 1 / S/S 2

LOS RCVR #1 / LOS RCVR #2 — LOS CMD CPU 1 / LOS CMD CPU 2 / BACK-UP CMD DECODER / LOS RCV SCI I/F

SCI LOS DATA — LOS TX #1 / LOS TX #2

PCM ENCODER O/P

SCIENCE DATA — CPU 1 / CPU 2

GPS ADU1 #1 / GPS ADU2 #2 — FLT CPU #1 / FLT CPU #2

GPS ADU #1 / GPS ADU #2 — TDRSS ACU

TDRSS CMD — CPU 1 / CPU 2 / B/U CMD DECODER

SIGNAL SWITCHING UNIT

**Linda Thompson
Code 584W
November 4-5,1998**

**ULDB
PDR**

**3.4.1
Data
Acquisition &
Command**

**Linda Thompson
Code 584W
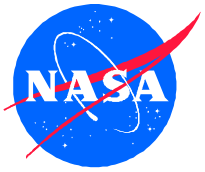November 4-5,1998**

HWCI 3.4.1.7
Data Distribution Units
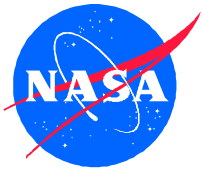
HWCI 3.4.1.7
Data Distribution Units

- Functional and Performance Requirements

    3.4.1.7.a - Provide non-buffered distribution of Ballooncraft analog signals to required destinations

    3.4.1.7.b - Provide non-buffered distribution of Ballooncraft digital signals to required destinations

    3.4.1.7.c - Provide signal test points

    3.4.1.7.d - Provide modifiable distribution connections

    3.4.1.7.f - Maintain functionality in ULDB environment for mission duration

ULDB
PDR

3.4.1
Data
Acquisition &
Command

Linda Thompson
Code 584W
November 4-5,1998

- Overview
  - Data distribution locations
    - Distributes both analog and digital signals
    - Reduces size of wire harnesses and spider webs
    - Reduces system check-out time
    - Simplifies modifications
    - Eases distribution of signals
    - Used for "hard-wired" PCM signals and system stack analog and digital input
  - Use in-house fabricated boards
    - 90° solder connectors
    - Analog and digital boards separated by stand-offs
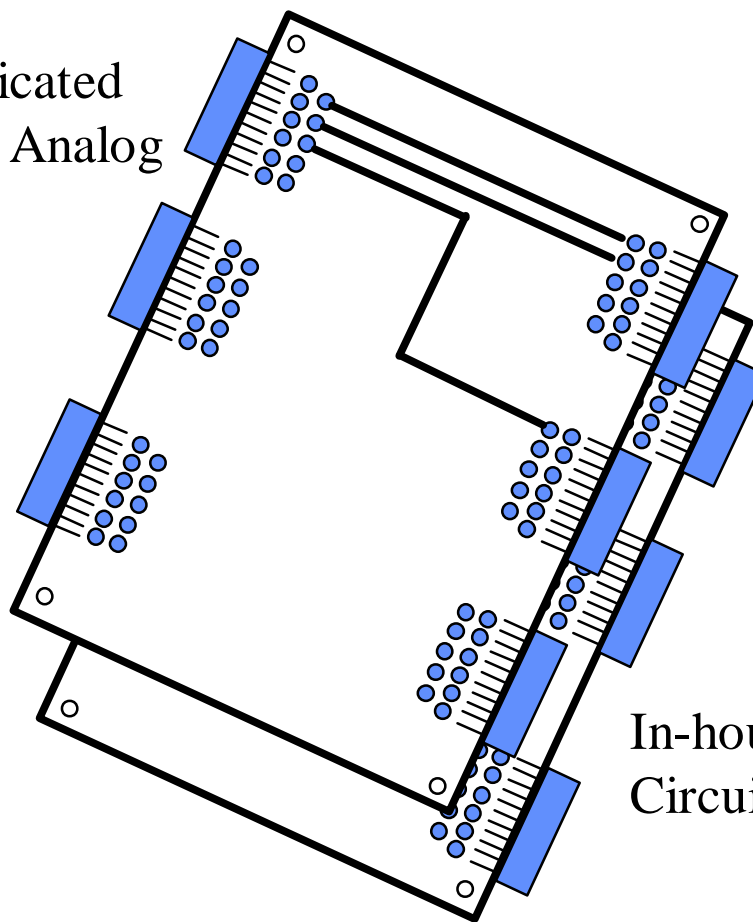   - Jumper programmable terminals

HWCI 3.4.1.4.7
Data Distribution Units

**3.4.1
Data
Acquisition &
Command**

In-house Fabricated
Circuit Card - Analog

In-house Fabricated
Circuit Card - Digital

**3.4.1
Data
Acquisition &
Command**

*HWCI 3.4.1.8
RF Cables*

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Code 584W
November 4-5,1998

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- Functional and Performance Requirements

    3.4.1.8.a - Provide RF connections between receivers and
    antennas

    3.4.1.8.b - Provide RF connections between transmitters
    and antennas

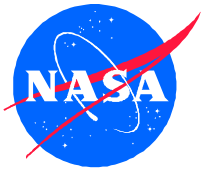   3.4.1.8.c - Maintain functionality in ULDB environment
    for mission duration

HWCI 3.4.1.4.8
RF Cables

ULDB
PDR

3.4.1
Data
Acquisition &
Command

- Description
  - Mechanical
    - LDF4-50A
      - Dimensions (nominal diameter inches): .63
      - Weight: (lbs/ft.): .15
    - FSJ4-50B
      - Dimensions (nominal diameter inches): .52
      - Weight: (lbs/ft.): .14
    - Inner Conductor: Copper-Clad Aluminum
    - Outer Conductor: Copper
  - Environmental
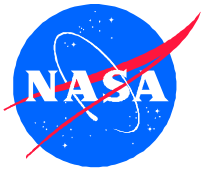   - Temperature: -40°C to +165°C
    - Humidity: 100% Impervious

- Description
  - Electrical
    - Impedence, ohms: 50
    - Average power, kW (400 - 3000 MHz):
      - LDF4-50A: 1.64 - .532
      - FSJ4-50B: 1.48 - .469

        ambient temperature 40°C
    - Nom. Attenuation dB/100ft (400 - 3000 MHz):
      - LDF4-50A: 1.42 - 4.38
      - FSJ4-50B: 2.18 - 6.88

        ambient temperature 25°C

HWCI 3.4.1.4.8
RF Cables

- Risk Assessment & Mitigation/Reliability
  - Used in the LDB
  - Design to meet "Design & Manufacturing Standard for Electrical Harnesses" ISO 565-PG-8700-2.1
  - COTS